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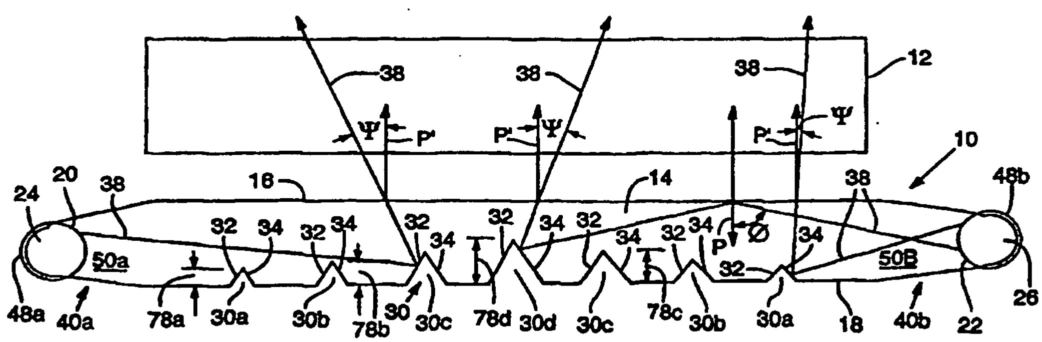

(57) Abstract

A liquid crystal display backlight (10) includes a light pipe (14) having substantially parallel front and rear planar surfaces (16, 18) and a pair of opposed ends (20, 22). Elongated prisms (30) are formed into the rear surface. Each prism includes a pair of oppositely inclined faces (32, 34) that extend into the light pipe. Light (38) is injected into the light pipe at the opposed ends so that the light strikes the prisms and is reflected out the front surface.

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LIQUID CRYSTAL DISPLAY BACKLIGHT

Technical Field

The present invention relates to backlights for liquid crystal displays and, in particular, to a backlight having improved efficiency and structural strength.

Background of the Invention

Direct view liquid crystal displays are used in a wide variety of products that include laptop-style personal computers. Some of these liquid crystal displays render an image by selectively controlling ambient light as it propagates through the display. Most high performance liquid crystal displays include a light source positioned behind the display opposite an observer or operator. Such light sources are referred to as backlights.

U.S. Patent No. 5,050,946 of Hathaway et al. describes a backlight system that includes a generally planar light pipe having a flat front surface and a stair stepped or faceted rear surface. Light is injected into the ends of the light pipe. The light propagates along the light pipe until it strikes the stairstep facets and is reflected out the front surface through a diffuser. A reflector is positioned behind the light pipe to direct toward the front surface any light that passes through a stairstep facet.

The light pipe of Hathaway et al. suffers from the disadvantage of providing relatively nonuniform illumination. The stairstep facets are suitable for reflecting light propagating in only one direction. For the stairstep facets positioned closer to it, a light source has a proportionately larger effective source size than for the stairstep facets positioned farther away, thereby resulting in the closer stairstep facets reflecting proportionately more light out the front surface.

Moreover, the combination of stairstep facets and rear reflector appears to cause an undesireably large amount of light to be directed out the front surface at oblique angles to the plane of the light pipe. Light propagating at such oblique angles cannot properly illuminate a liquid crystal display and, therefore, does not contribute to the apparent brightness of the backlight system.

Some liquid crystal displays are used transmissively in, for example, overhead projection display systems, and other liquid crystal displays may be used for either transmissive or direct viewing. In the latter type of liquid crystal display, a backlight system that is opaque when viewed from its rear, such as the backlight system of Hathaway et al., must be removed to allow transmissive viewing of the display.

Summary of the Invention

An object of the present invention is, therefore, to provide a backlight for liquid crystal displays.

Another object of this invention is to provide a backlight with improved illumination uniformity.

A further object of this invention is to provide such a backlight through which light can pass for transmissive viewing of a liquid crystal display.

A preferred embodiment of the present invention includes a liquid crystal display backlight having a light pipe that includes substantially parallel front and rear planar surfaces and a pair of opposed ends. Multiple elongated prisms are formed into the rear surface. Each prism includes a pair of oppositely inclined faces that extend into the light pipe and meet each other.

Light is injected into the light pipe at the opposed ends so that the light strikes the prisms and is reflected out the front surface. The oppositely inclined faces of each prism allow all prisms to reflect out the front surface light from either of the ends. As a result, the liquid crystal display backlight provides substantially uniform illumination across the front surface.

Preferably, the rear surface of the backlight of the present invention does not include a reflector for redirecting out the front surface light that escapes the rear surface. As a result, the backlight allows transmissive viewing of a liquid crystal display and has decreased amounts of light directed at oblique angles to the front surface. To further reduce the amount of light directed at oblique angles and provide increased apparent brightness, a diffuser is preferably not employed as the front surface of the backlight.

Additional objects and advantages of this invention will be apparent from the following detailed description of preferred embodiments thereof which proceeds with reference to the accompanying drawings.

Brief Description of the Drawings

Fig. 1 is a simplified side view of a backlight of the present invention positioned adjacent a liquid crystal display.

Fig. 2 is a simplified exploded isometric view of the backlight of Fig. 1.

Fig. 3 is a schematic side view of a first preferred embodiment of an injector arrangement for injecting light into a light pipe according to the present invention.

Fig. 4 is a schematic side view of a second preferred embodiment of an injector arrangement for injecting light into a light pipe according to the present invention.

Fig. 5 is a simplified side view of an alternative backlight of the present invention positioned adjacent a liquid crystal display.

Fig. 6 is a simplified side view of another alternative backlight of the present invention positioned adjacent a liquid crystal display.

Detailed Description of Preferred Embodiments

Referring to Figs. 1 and 2, a liquid crystal display backlight 10 of the present invention provides light for direct viewing of a liquid crystal display 12 and is sufficiently transparent to be compatible with transmissive projection displays. Backlight 10 includes a transparent planar light pipe 14 having a front surface 16 and a rear surface 18 that are generally parallel with each other.

Light pipe 14 terminates at a pair of opposed light-receiving ends 20 and 22 adjacent to which respective elongated light sources 24 and 26 are positioned. Multiple elongated prisms 30 (shown enlarged and in reduced numbers for purposes of clarity) are formed into rear surface 18. Each prism 30 includes a pair of oppositely inclined faces 32 and 34 that extend into light pipe 14. Faces 32 and 34 intersect at a full angle that is preferably about 90°, but that can range between 110° and 70°. Prisms 30 are oriented with their lengths extending in a direction that is not perpendicular to light-receiving ends 20 and 22, so that faces 32 and 34

receive light from light sources 24 and 26.

Corresponding prisms 30a, 30b, and 30c are positioned on opposite sides of a central axis 36. A central prism 30d is positioned approximately at central axis 36. Light pipe 14 could include, for example, multiple central prisms 30d and multiple corresponding prisms 30a, 30b, and 30c on each side of central prisms 30d.

Fig. 3 is a schematic side view of a first preferred embodiment of an injector arrangement 40a for directing or injecting light 38 from light source 24 into end 20. A similar injector arrangement 40b directs light from light source 26 into end 22. Injectors 40a and 40b have substantially similar components that are designated the respective suffices "a" and "b". The following description directed to injector arrangement 40a is similarly applicable to injector arrangement 40b.

Light source 24 has a cylindrical shape, as is typical for cold cathode fluorescent lamps, with a diameter 42a (e.g., 5 mm.) comparable to thickness 44 (e.g., 6 mm.) of light pipe 14. Injector arrangement 40a includes at end 20 an elongated arcuate recess 46a that complements and receives a segment of light source 24. Light source 24 includes a reflective coating 48a that covers the interior of light source 24 except where it meets recess 46a. As a result, light 38 generated within light source 24 is emitted therefrom only into end 20.

A ramp segment 50a of light pipe 14 has opposing faces 52a and 54a that diverge from each other as they extend from end 46. Ramp segment 50 internally reflects diverging rays of light 38 so that they propagate substantially along light pipe 14. Several exemplary rays 38 are shown. Opposing faces 52a and 54a diverge to about thickness 44 of light pipe 14.

Fig. 4 is a schematic side view of a second

preferred embodiment of an injector arrangement 60a for directing or injecting light 38 from light source 24 into end 20. A similar injector arrangement 60b directs light from light source 26 into end 22. Injectors 60a and 60b have substantially similar components that are designated the respective suffices "a" and "b". The following description directed to injector arrangement 60a is similarly applicable to injector arrangement 60b.

Light source 24 has a cylindrical shape and a diameter 62a (e.g., 3 mm.) substantially less than thickness 44 (e.g., 6 mm.) of light pipe 14. Injector arrangement 60a includes at end 20 an elongated arcuate recess 64a that complements and receives a segment of light source 24. Light source 24 does not include an interior reflective coating, so light 38 generated within light source 24 is emitted therefrom in all directions in the plane of Fig. 4.

Some portions of light 38 enters end 20 at arcuate recess 64a, and other portions are reflected from an interior surface of an elongated parabolic reflector 66a and enter end 20 at one of a pair of flat windows 68a and 70a. A ramp segment 72a of light pipe 14 has opposing faces 74a and 76a that diverge from each other as they extend from recess 64a to end faces 68a and 70a. Ramp segment 72a internally reflects diverging rays of light 38 so that they propagate substantially along light pipe 14. Several exemplary rays 38 are shown.

Injector arrangements 40 and 60 may be used alternatively according to the size of light sources 24 and 26 required for the application. For example, larger-diameter light sources 24 and 26 could be used to obtain brighter illumination. Smaller-diameter light sources 24 and 26 could be used in portable display systems having limited battery power supplies.

Light 38 injected into light pipe 14 propagates

along it and typically strikes front surface 16 and rear surface 18. Because of the steep angle at which injector arrangements 40 and 60 direct it into light pipe 14, light 38 that strikes front surface 16 or a parallel portion of rear surface 18 typically does so at a large angle of incidence ϕ (Fig. 1) and is totally internally reflected. Angle of incidence ϕ is typically greater than about 40°, as measured relative to an inward direction P that is perpendicular to front surface 16.

When it strikes a face 32 or 34 of a prism 30, light 38 is again internally reflected, but is directed out front surface 16 at a relatively small angle ψ (Fig. 1) relative to an outward direction P' perpendicular to front surface 16. (According to convention, the angles of light rays that are internally reflected by or pass through a surface are measured relative to inward and outward perpendiculars, respectively.) As a result, light 38 reflected by prism 30 propagates through front surface 16 to illuminate liquid crystal display 12. Since they each include a pair of oppositely inclined faces 32 and 34, prisms 30 are capable of reflecting toward front surface 16 light from either of light sources 24 and 26. As a result, light pipe 14 is highly efficient at internally reflecting light out front surface 16.

It will be appreciated that the amount of light 38 propagating from an end 20 or 22 decreases as portions of the light are reflected out front surface 16. To compensate for the decreased amounts of light, corresponding prisms 30a, 30b, and 30c have respective depths 78a, 78b, and 78c into light pipe 14 that increase successively with the distance of the prisms from ends 20 and 22. Central prism 30d is positioned furthest from ends 20 and 22 and has a maximum depth 78d. Exemplary depths 78a-78d can range from 0.004 mm to 0.020 mm. The changes in successive depths can correspond to linear or

non-linear functions that increase with the distance from the nearest end or, equivalently, decrease with distance from central axis 36. An example of such a non-linear function is a Gaussian function in which depth is proportional to the negative power of the square of the distance from central axis 36.

The angles at which faces 32 and 34 of prisms 30 intersect can also be varied to compensate for the decreased amounts of light along light pipe 14. For example, angles of intersection from 70° to 90° would form prisms 30 with increasing tendencies to reflect light out front surface 16.

The spacing between adjacent prisms 30 can be substantially uniform or can vary with the distance from ends 20 and 22. For example, the spacing between adjacent prisms 30 can decrease with the distance from ends 20 and 22, to further compensate for decreased amounts of light 38. To prevent undesirable Moire interference patterns from being formed between light pipe 14 and liquid crystal display 12, the spacing between adjacent prisms 30 should be chosen to make the interference spacing too small to be visible.

Light pipe 14 may be formed of a panel of transparent material with a relatively high refractive index of between 1.49 and 1.59. Exemplary materials include acrylic, polystyrene, and polycarbonate. Prisms 30 can be formed into light pipe by, for example, compression molding or extrusion. Light sources 24 and 26 are preferably cold cathode fluorescent lamps such as, for example, Model No. CBY3-250S manufactured by Stanley of Japan. Such lamps provide substantially uniform illumination along their lengths and are relatively inexpensive.

As a panel of transparent material, light pipe 14 allows light transmitted from behind rear surface 18 to

propagate through to liquid crystal display 12. This feature makes backlight 10 particularly desireable in display systems that are convertible between direct and projection viewing configurations. One such system is described in U.S. Patent No. 5,353,075 of Conner et al. for Convertible Flat Panel Display System.

In such a convertible display system, backlight 10 can illuminate liquid crystal display system 12 when it is viewed directly. Unlike some prior backlights, however, backlight 10 does not include a reflector positioned at rear surface 18 or a diffuser positioned at front surface 16. The reflectors positioned at the rear surfaces of some prior backlights prevent them from having any transmissive use. The diffusers positioned at the front surfaces of other prior backlights prevents them from being used transmissively in projection display systems.

Diffusers increase the angular divergence of the light passing through them. In a projection display system, such divergence results in projection images with less light at the edges than in the center because some of the divergent light at the edges does not reach subsequent projection lenses. To compensate for such nonuniformity, larger optical elements could be used to capture the divergent light. However, such solutions are typically prohibitively expensive.

As a result of the reflectorless and diffuserless configuration of backlight 10, projection lighting can pass through light pipe 14 to liquid crystal display 12 when it is operated as a projection display device. Because it need not be removed, backlight 10 simplifies the conversion of such a display device between direct and projection display configurations. In such an application, prisms 30 would preferably account for a relatively small percentage of rear surface 18 to minimize

any possible image effects that could arise in the projection display configuration.

Fig. 5 is a simplified end view of an alternative liquid crystal display backlight 80 of the present invention positioned adjacent liquid crystal display 12. Backlight 80 provides light for direct viewing of liquid crystal display 12 and is transparent and diffuserless to be compatible with transmissive projection displays. Backlight 80 includes a transparent planar light pipe 84 having a front surface 86 and a rear surface 88 that generally tapers, preferably from both ends (as shown), relative to front surface 86.

Light pipe 84 terminates at a pair of opposed light-receiving ends 90 and 92 adjacent to which respective elongated light sources 94 and 96 are positioned. Multiple elongated stairstep facets 100 (shown enlarged and in reduced numbers for purposes of clarity) are formed into rear surface 88. Each stairstep facet 100 includes an inclined face 102 that extends into light pipe 14 at an angle that is preferably about 45°, but that can range between 55° and 35°.

Corresponding stairstep facets 100a, 100b, and 100c are positioned on opposite sides of a central axis 106. Each of a central pair of stairstep facets 100d is positioned on opposite sides of central axis 106. Light pipe 84 could include, for example, multiple central stairstep facets 100d and multiple corresponding stairstep facets 100a, 100b, and 100c on each side of the central stairstep facets 100d. Stairstep facets 100 are separated from each other by flat segments 108 that are parallel to front surface 86. Stairstep facets 100 provide rear surface 88 with a generally tapered or wedge configuration relative to front surface 86.

Backlight 80 can illuminate liquid crystal display system 12 when it is viewed directly. Moreover, a

diffuser is not positioned at front surface 86, and a reflector is not positioned at rear surface 88. As a result of the reflectorless and diffuserless configuration of backlight 80, projection lighting can pass through light pipe 84 to liquid crystal display 12 when it is operated as a projection display device. This feature makes backlight 80 particularly suitable for display systems that are convertible between direct and projection viewing configurations, as described hereinabove with reference to backlight 10.

Fig. 6 is a simplified end view of another alternative liquid crystal display backlight 110 of the present invention positioned adjacent liquid crystal display 12. Backlight 110 has components that are similar to those of backlight 80 and are identified by common reference numerals.

Backlight 110 differs from backlight 80 by having a light pipe 112 with only one light-receiving end 114 and a rear surface 116 that generally tapers relative to front surface 86 from light-receiving end 114 to a reflective end face 118. An elongated light source 120 is positioned adjacent light-receiving end 114.

Typically, only a relatively small amount of light 38 from light source 120 will reach reflective end face 118. However, none of this light contributes to the apparent brightness off backlight 110. Reflective end face 118 directs all this light 38 back through light pipe 112 to be redirected out front surface 86. To improve the likelihood that the light it reflects will strike a stairstep facet 100 and be reflected out front surface 86, end face 118 is preferably not perpendicular to front surface 86. For example, end face 118 may be inclined relative to front surface 86 as shown. Alternatively, end face 118 may be inclined in a direction opposite to that shown, or may have a concave or convex curvature rather

than being flat as shown.

It will be obvious to those having skill in the art that many changes may be made to the details of the above-described embodiment of this invention without departing from the underlying principles thereof. For example, all prisms 30 could be formed with a common depth into light pipe 14. The scope of the present invention should be determined, therefore, only by the following claims.

Claims

1. A liquid crystal display backlight for illuminating a liquid crystal display, comprising:

a planar transparent light pipe having generally parallel front and rear surfaces with a pair of opposed light-receiving ends, the front surface being positionable in face-to-face relation to a liquid crystal display and the rear surface including plural elongated prisms formed therein with their lengths oriented in a direction that is not perpendicular to the light-receiving ends;

an elongated light source positioned adjacent each of the light-receiving ends and adapted for directing light into them such that the light propagates within the light pipe until the light is reflected by a prism; and

an illumination direction through the front surface of the light pipe, the illumination direction adapted for propagating the light reflected by the prisms to illuminate the liquid crystal display.

2. The backlight of claim 1 in which the elongated prisms include elongated, oppositely inclined faces that extend into the light pipe from its rear surface.

3. The backlight of claim 2 in which the oppositely inclined faces of each prism meet at a full angle of between 110° and 70°.

4. The backlight of claim 1 in which the light pipe has a central axis and the prisms have depths into the light pipe which depths decrease with the distance of the prisms from the central axis.

5. The backlight of claim 1 further including a major light-receiving surface for receiving light from a second light source positionable behind the backlight, the major light-receiving surface allowing light received from the second light source to propagate through the light pipe and out the front surface.

6. The backlight of claim 5 in which the rear surface of the light pipe is the major light-receiving surface.

7. The backlight of claim 1 further including a major light-exiting surface from which light passes from the backlight toward the liquid crystal display, the light passing from the major light-exiting surface to a liquid crystal display substantially without divergence from the illumination direction.

8. The backlight of claim 7 in which the front surface of the light pipe is the major light-exiting surface.

9. A liquid crystal display backlight light pipe for directing light toward a liquid crystal display, comprising:

a planar transparent panel having generally parallel front and rear surfaces with a pair of opposed light-receiving ends, the rear surface including plural elongated prisms formed therein with their lengths oriented in a direction that is not perpendicular to the light-receiving ends such that the light introduced into the light-receiving ends propagates within the panel until the light is reflected by a prism and propagates out the front surface to illuminate the liquid crystal display.

10. The light pipe of claim 9 having a central axis and in which the prisms have depths into the light pipe which depths decrease with the distance of the prisms from the central axis.

11. The light pipe of claim 9 in which the elongated prisms include elongated, oppositely inclined faces that extend into the light pipe from its rear surface.

12. The light pipe of claim 11 in which the oppositely inclined faces of each prism meet at an angle of between 110° and 70°.

13. A liquid crystal display backlight for illuminating a liquid crystal display, comprising:

a planar transparent light pipe having front and rear major surfaces and a light-receiving end, the front surface being positionable in face-to-face relation to a liquid crystal display and the rear surface including plural elongated inclined faces formed therein with their lengths oriented in a direction that is not perpendicular to the light-receiving end;

a major light-receiving surface for receiving light from a first light source positionable behind the backlight, the major light-receiving surface allowing light received from the first light source to propagate through the light pipe and out the front surface;

an elongated second light source positioned adjacent the light-receiving end and directing light into it, the light from the elongated second light source propagating within the light pipe until the light is reflected by an inclined face and propagates in an illumination direction out the front surface to illuminate the liquid crystal display; and

a major light-exiting surface from which light passes from the backlight toward the liquid crystal display, the light passing from the major light-exiting surface substantially without divergence from the illumination direction.

14. The backlight of claim 13 in which the rear surface of the light pipe is the major light-receiving surface.

15. The backlight of claim 13 in which the front surface of the light pipe is the major light-exiting surface.

16. The backlight of claim 13 in which adjacent pairs of inclined faces are inclined in opposite directions to form prisms that extend into the light pipe

from its rear surface.

17. The backlight of claim 13 in which multiple adjacent inclined faces are inclined in the same direction to form stairstep facets that extend into the light pipe from its rear surface and provide it with a generally tapered configuration relative to the front.

18. The backlight of claim 13 comprising a pair of light-receiving ends and corresponding elongated second and third light sources, the pair of light receiving ends being positioned in opposition to each other across the light pipe.

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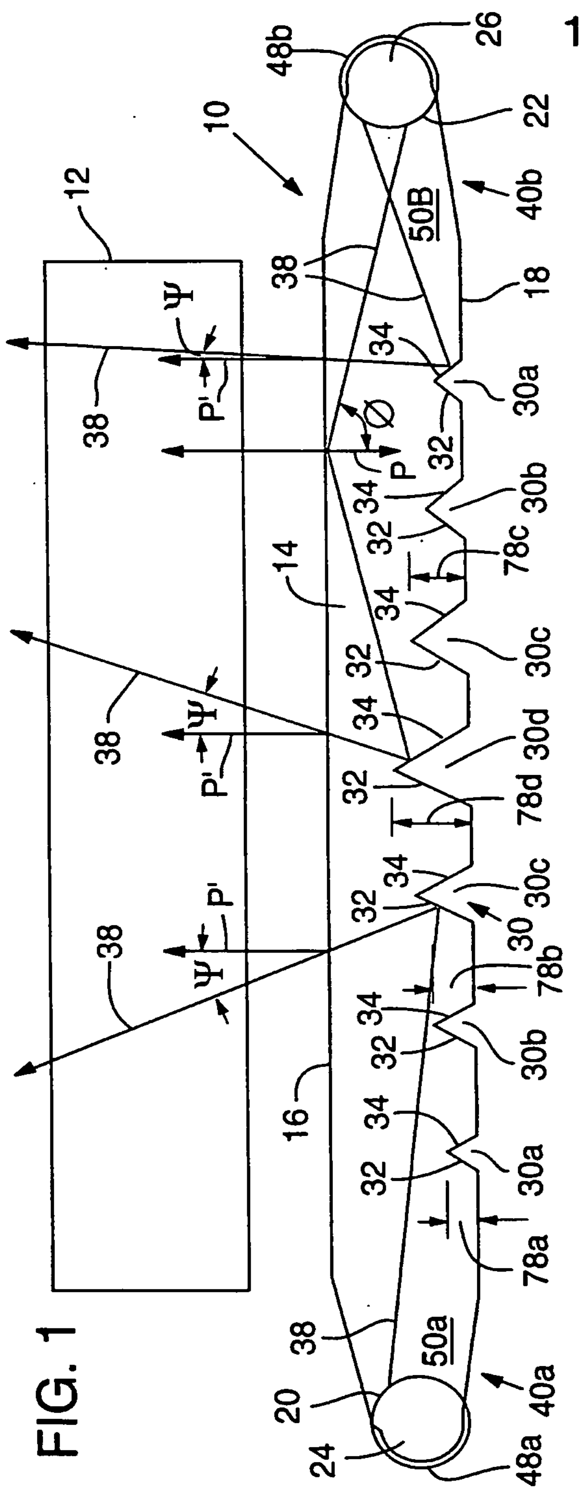

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FIG. 1

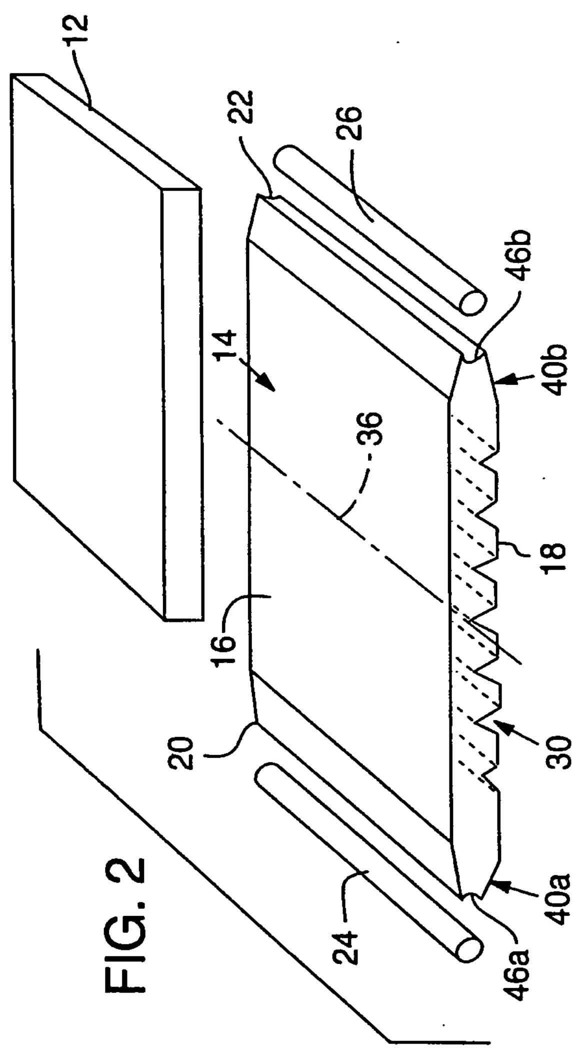

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FIG. 2

FIG. 3

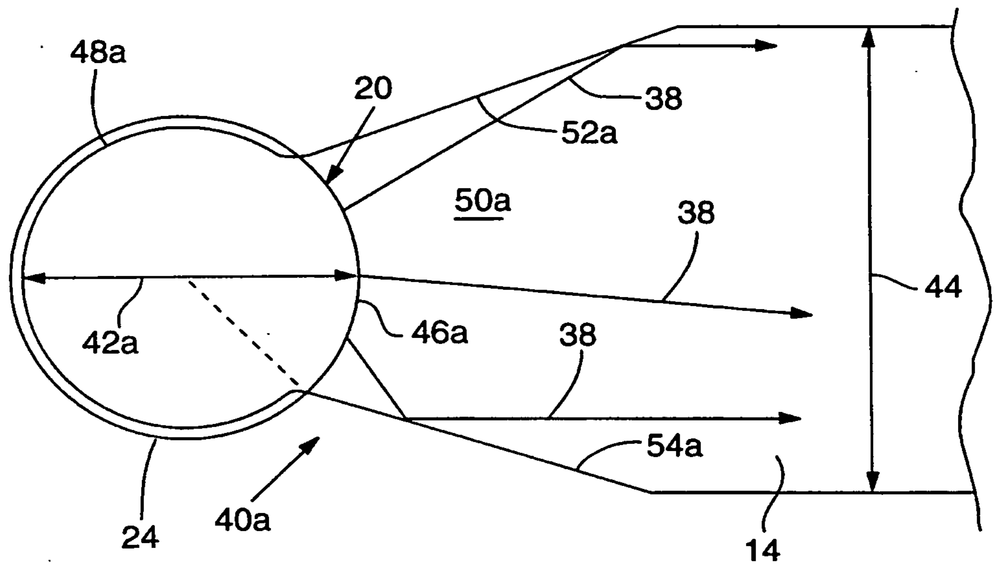
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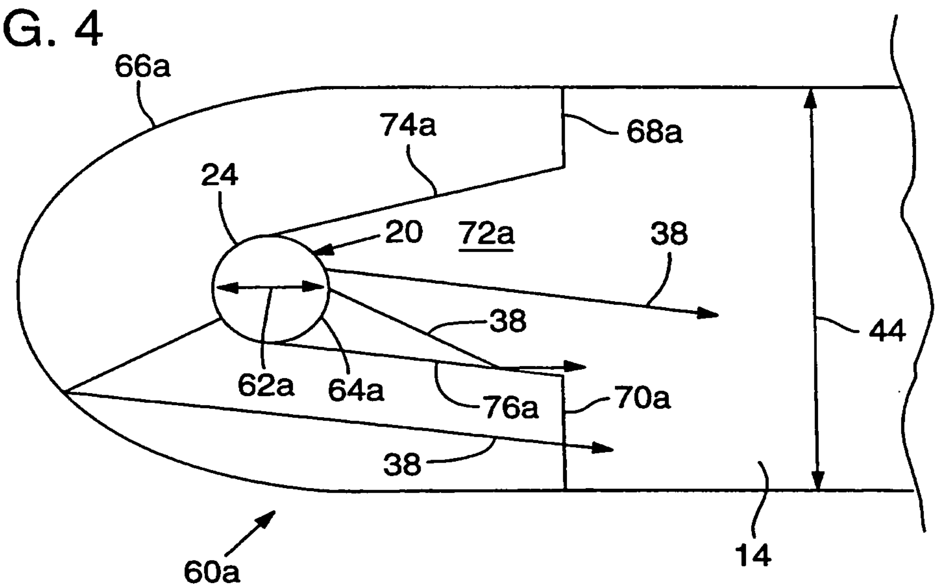
FIG. 4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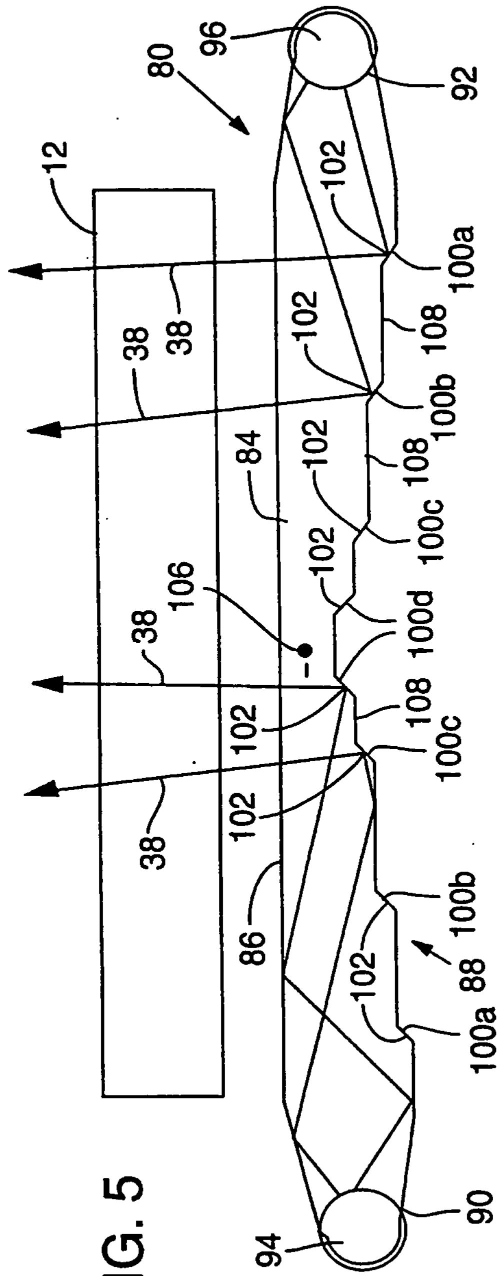
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FIG. 5

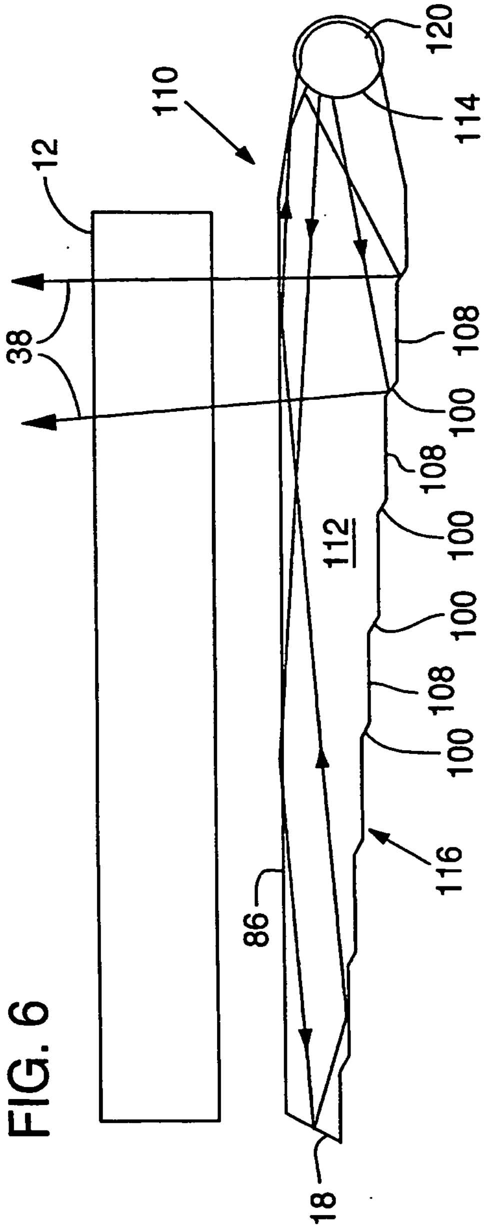
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FIG. 6

INTERNATIONAL SEARCH REPORT

Interr ·nal Application No
PCT/US 95/06209

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F21V8/00 G02F1/1335

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F21V G02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB,A,2 162 300 (SHARP) 29 January 1986 see the whole document	13-17
Y		5-8,18

X	PATENT ABSTRACTS OF JAPAN vol. 9 no. 101 (P-353) [1824] ,2 May 1985 & JP,A,59 226303 (SUWA SEIKOSHA K.K.) 19 December 1984, see abstract	13-16

Y	US,A,5 079 675 (NAKAYAMA) 7 January 1992 see column 4, line 31 - line 52 see figures 8,9	5-8
A		1-3,9, 11,12

Y	US,A,4 528 617 (BLACKINGTON) 9 July 1985 see figure 5	18

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Date of the actual completion of the international search	Date of mailing of the international search report
21 September 1995	28.09.95

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INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/US 95/06209

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR,A,1 580 461 (NEC) 5 September 1969 see page 1, line 27 - line 28 see figure 2 -----	4,10

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 95/06209

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A-2162300	29-01-86	JP-C- 1662642	19-05-92
		JP-B- 3027908	17-04-91
		JP-A- 61034583	18-02-86
		DE-A- 3526511	06-02-86
		US-A- 4914553	03-04-90
US-A-5079675	07-01-92	NONE	
US-A-4528617	09-07-85	NONE	
FR-A-1580461	05-09-69	NONE	